Variable plumage coloration of breeding Barbary Falcons *Falco (peregrinus) pelegrinoides* in the Canary Islands: do other Peregrine Falcon subspecies also occur in the archipelago?

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Summary.—The taxonomic status of the Barbary Falcon has been controversial for many years, it being variously considered a subspecies of Peregrine Falcon (*Falco peregrinus pelegrinoides*) or treated as a full species (*F. pelegrinoides*). Although morphological and molecular studies are still scarce, they suggest that subspecific status is more appropriate. Other subspecies of Peregrine, such as *F. p. brookei*, exhibit some plumage characteristics similar to Barbary Falcon. We quantitatively describe coloration patterns of Barbary Falcons breeding in the Canary Islands, based on photographs of wild birds, injured or dead individuals brought to rehabilitation centres, and specimens deposited in museum collections. We tested sexual differences, and compared Canaries falcons with a sample of specimens labelled as *F. p. brookei*. Males of both taxa are usually paler and possess less barred underparts than females. The majority (>60%) of birds in the Canaries have a Barbary Falcon-like appearance, but there is much overlap with *F. p. brookei*. This variation in coloration could be natural or relate to escaped falconry birds, meaning that molecular studies are needed to clarify the identity of wild falcons on the Canary Islands.

Peregrine Falcon *Falco peregrinus*, with at least 19 recognised subspecies worldwide, is one of the best-studied diurnal raptors (Ratcliffe 1993, White *et al.* 2002, Sielicki & Mizera 2009). However, for many of these races, such as the endemic Cape Verde Peregrine Falcon *F. p. madens*, few data are available concerning their general biology (Anderson & White 2000). For others, such as the pallid phase of the South American Peregrine *F. p. cassini* (formerly *F. p. kreyenborgi*) and the Black Shaheen *F. p. peregrinator*, although more biological data are available, their taxonomic status has been controversial for many years (Ellis & Garat 1983, White & Boyce 1988, Döttlinger 2002). Some authors have considered Barbary Falcon a subspecies of Peregrine (*F. p. pelegrinoides*: Helbig *et al.* 1994, del Hoyo *et al.* 1994, Wink & Seibold 1996), whilst others have treated it as a separate species, with two subspecies, *F. pelegrinoides pelegrinoides* and *F. p. babylonicus* (Vaurie 1961, Clark & Shirihai 1995, Ferguson-Lees & Christie 2001). Genetically, they appear to be very similar to other Peregrines (Wink *et al.* 2000), but morphologically they present very distinctive size and coloration patterns (Vaurie 1961, Clark & Shirihai 1995, Forsman 1999). Compared to Peregrine, this mid-sized falcon is slightly smaller, paler, has a more compact body shape, a very short-tailed silhouette in flight, and a different head pattern with a rufous patch on the nape (Clark & Shirihai 1995, Shirihai *et al.* 1998, Forsman 1999). Differences in skeleton features have also been described compared to other Peregrine subspecies (Vaurie 1961, White & Boyce 1988, Johansson *et al.* 1998).

Morphologically, Barbary Falcon and Peregrine *F. peregrinus brookei* can overlap (Forsman 1999), but in the past it was suggested that they do not hybridise in the wild (Vaurie 1961, Ferguson-Lees & Christie 2001). Recently, however, mixed pairs of Barbary

Falcons × *F. p. brookei* and individuals with coloration patterns intermediate between these falcons have been observed at several localities (Forsman 1999, Schollaert & Gilles 2000, Zuberogoitia *et al.* 2002, Rodríguez *et al.* 2009). The name '*atlantis*' has been used in relation to such intermediates between *F. p. brookei* and Barbary Falcon observed in Morocco (Schollaert & Dufourny 1995, Schollaert & Gilles 2000), and a preliminary genetic study has demonstrated that some birds on Fuerteventura (Canary Islands) possess the Barbary phenotype but also haplotypes of *F. p. brookei*, suggesting recent hybridisation (Amengual *et al.* 1992). During recent decades many ornithologists have studied the field identification of Barbary Falcon (Brosset 1986, Clark & Shirihai 1995, Wink & Seibold 1996, Shirihai *et al.* 1998, Forsman 1999, Schollaert & Gilles 2000, Corso 2001), but few studies have aimed to quantify its morphology (see Dementiev 1957, Vaurie 1961, White & Boyce 1988).

The Canary Islands mark the westernmost limit of the breeding range of Barbary Falcons (Ferguson-Lees & Christie 2001). In nearby Morocco, populations of Barbary, *F. p. brookei* and *F. p. minor* regularly breed, whilst in Iberia only *F. p. brookei* occurs as a breeder, although *F. p. calidus* and *F. p. peregrinus* regularly winter in both countries (Brosset 1986, Zuberogoitia *et al.* 2002). Here we describe, for the first time, variation in coloration patterns in falcons on the Canary Islands. Furthermore, we remark on the presence of breeding falcons in the archipelago whose morphology resembles *F. p. brookei*, based on comparison between Canaries birds and museum specimens from Iberia.

Methods

Study area and falcon population.—The Canary Islands are a volcanic archipelago situated 100 km off the north-west Atlantic coast of Africa. They comprise seven major islands (from east to west: Lanzarote, Fuerteventura, Gran Canaria, Tenerife, La Gomera, La Palma and El Hierro), and several islets (Alegranza, Montaña Clara, La Graciosa and Lobos) and small marine rocks. Besides the breeding falcons, there are observations of migrant Peregrines in the archipelago (Martín & Lorenzo 2001). The Barbary Falcon population on the islands was considered threatened, but currently is increasing in numbers and range (a 17.6% mean annual increase was estimated in 1989–2007; Rodríguez *et al.* 2009), and the archipelago currently supports approximately 144 pairs (Siverio *et al.* 2009). For now, we consider the taxon to be a subspecies of Peregrine until molecular studies are undertaken.

General procedures.—We studied coloration patterns of 66 adult falcons from all of the major islands in the Canaries archipelago, except La Gomera and La Palma (see Appendix). For each individual, we recorded sex (based on size) and plumage colour using photographs or video recordings of wild birds, injured or dead animals admitted to wildlife rehabilitation centres, or museum specimens (Appendix). The majority of these data pertain to birds from the period 2000–10, but some specimens were collected in the early 20th century (Appendix). Except in a few cases (18%), we are certain that adults from the Canaries were breeders. Where possible we noted sex, locality and date to avoid repetition in the sample of wild individuals. Furthermore, we studied photographs of 26 specimens held at the Estación Biológica de Doñana CSIC (EBD, Seville) labelled *F. p. brookei* (collected in Iberia), and adult specimens belonging to the type series of Cape Verde Peregrine *F. p. madens* in the Yale Peabody Museum of Natural History, New Haven (YPBM; Appendix).

We adopted similar procedures to those of White & Boyce (1988), McDonald (2003) and Zuberogoitia *et al.* (2009a) to describe and code phenotypic characteristics of each adult. Because we lacked high-quality photograph of all birds, sample sizes differ between characters. Furthermore, because many birds were not studied in the hand, we could not measure directly facial characters. We endeavoured to obtain three facial measurements for

TABLE 1
Description of plumage characteristics of adult falcons and codes used in the present study.

Feature	Description	Scores		
		1	2	3
Superciliary	Presence or absence of pale superciliary stripe	Clearly visible	Absent or very small	-
Forehead	Presence or absence of pale spot	Clearly visible	Absent or very small	-
Nape	Size of rufous / reddish area on the nape	Single large rufous patch	Clearly visible rufous lines	Absent or too small to see
Back	Relative darkness of the upperparts	Paler	Intermediate	Darker
Upper breast	Presence of spots	Unmarked	Partially marked on lower half	Fully marked
Breast	Intensity of barring	Almost white or only slightly barred on flanks	Barred	Heavily spotted
Colour	General colour of the ventral surface	White	Cream	Pinkish or rufous

each bird, expressed relative to eye dimension: width of the moustachial at the midpoint, width of the pale cheek patch from the distal tip to upper end of the ear-coverts, and width of the dark patch between the eye and upper end of the paler ear-coverts (see Fig. 1). We also coded seven coloration characters (Table 1). For each individual, we calculated an index of similarity to Barbary Falcon (ISBF) as follows: *Moustachial + Cheek + Black + Supercilary + Forehead + Nape + Back + Upper breast + Breast + Colour*.

Lower values conform to those birds with a typical Barbary phenotype (pale appearance, white forehead, presence of a superciliary stripe, red nape, larger cheek patch, etc.), while higher scores relate to Peregrine-like birds (dark with heavily spotted underparts, small cheek patch, no red on the nape and no superciliary or white on the forehead).

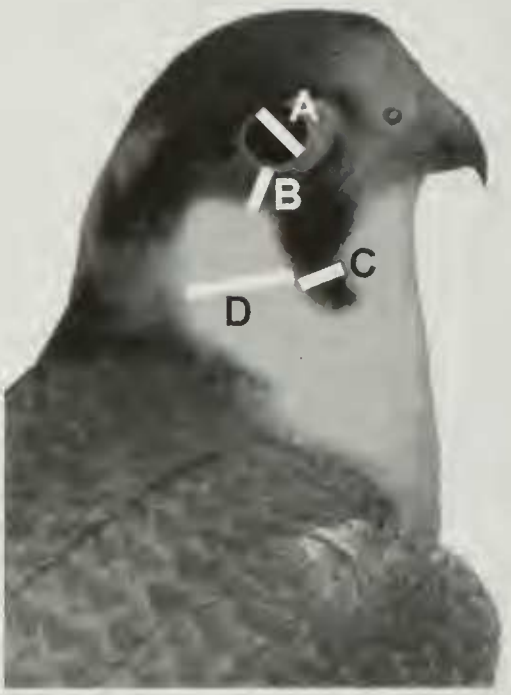

Figure 1. Diagram showing measurements taken of the head pattern of falcons from the Canary Islands and Iberia (A = eye dimension, B = black area below the eye, C = moustachial, D = cheek patch; see text for more details).

Statistical analyses.—Two-way ANOVAs were used to test differences in head patterns including by sex and origin (Canary Islands vs. Iberia) as factors. A Principal Component Analysis (PCA) with varimax rotation was performed to order and identify the contributions of each coloration variable (head pattern and general plumage) to establish possible differences between falcons from the Canaries and Iberia. A total of 78 falcons was analysed to calculate the correlation matrix. Bartlett's sphericity test ($\chi^2 = 202.4$; df = 28; $P < 0.001$) and KMO measure (0.759) indicated the adequacy of the correlation matrix. We extracted those principal components exhibiting Eigenvalues higher than 1. A Mann-Whitney *U*-test was employed to compare sexual differences in the head patterns of Canaries falcons. Statistical calculations were made using the SPSS (v.17.0) statistical package.

TABLE 2
Head pattern characters (mean ± SD) of falcons from the Canary Islands and Iberia (see text for further details), based on specimens and live birds (sample size in brackets). Significance level of two-way ANOVAs (sex and origin as factors) (significant values are placed in bold).

Character	Canary Islands *F. p. pelegrinoides*	Iberia *F. p. brookei*	F_{sex}	F_{origin}	$F_{interaction}$
Moustachial					
Male	1.15 ± 0.25 (26)	1.15 ± 0.29 (11)			
Female	1.30 ± 0.30 (29)	1.28 ± 0.30 (14)	**4.39**	0.23	0.04
Total	1.23 ± 0.29 (55)	1.22 ± 0.30 (25)			
Cheek patch					
Male	2.26 ± 0.58 (28)	1.42 ± 0.35 (11)			
Female	2.31 ± 0.65 (30)	1.72 ± 0.49 (14)	1.63	**27.29**	0.72
Total	2.30 ± 0.68 (58)	1.59 ± 0.45 (25)			
Black below eyes					
Male	1.01 ± 0.32 (28)	1.54 ± 0.44 (11)			
Female	1.18 ± 0.31 (30)	1.50 ± 0.39 (14)	0.54	**23.97**	1.27
Total	1.09 ± 0.33 (58)	1.22 ± 0.40 (25)			

Results

General description of falcons from the Canary Islands.—In general, Canaries falcons possess a narrow moustachial and large white cheek patch almost reaching the eye (Table 2). A total of 71% of birds have red or rufous on the nape (scores 1 or 2; Fig. 2). Almost half (48.4%) possess a white or pale patch on the forehead, and just 13.1% possess a superciliary stripe (Table 3, Figs. 2–4).

Those birds analysed by us exhibited all three scores for the darkness of the upperparts, but the majority (67.8%) presented intermediate (2) or paler scores (1) (Table 3; Figs. 2–4). In general, the upper breast and breast scored intermediate or low values in terms of barring (86.4% and 84.7%, respectively), but 13.6% and 15.3% had the heavily barred upper breast and breast, respectively, typical of Peregrine (Table 3). The underparts were cream-coloured in 66.1%, with the remainder white or pinkish-coloured (Table 3).

Comparison between F. p. pelegrinoides, F. p. brookei and F. p. madens.—Canaries falcons exhibit lower values in almost all plumage characteristics than Iberian birds (Tables 2–3), and possess a significantly larger pale cheek patch than falcons from Iberia and the smallest black area below the eyes (Table 2). ISBF values of Canaries falcons were significantly lower than Iberian falcons (13.1 ± 3.0 vs. 17.2 ± 2.4; $U = 213.5$, $P < 0.001$), although there is considerable overlap (Fig. 5). Some 63.6% and 16.1% of birds from the Canaries and Iberia, respectively, possessed ISBF val-

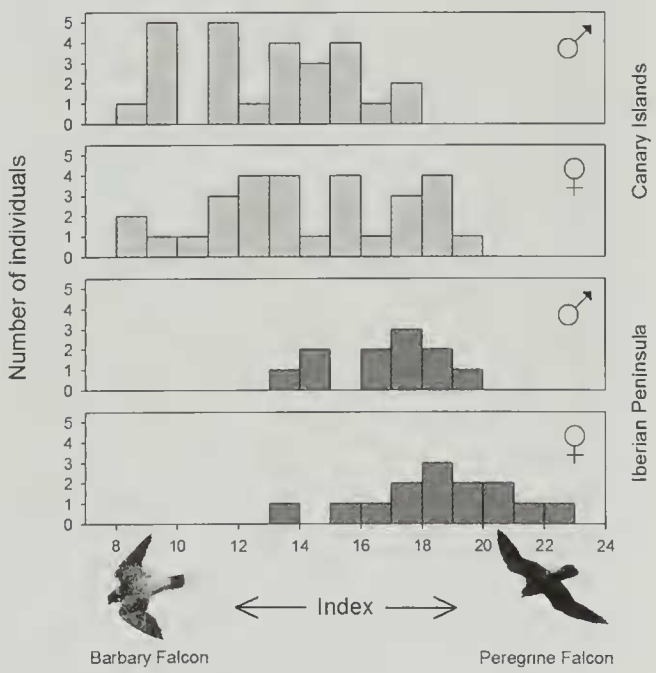

Figure 5. Variation in the Barbary–Peregrine phenotype index (ISBP) utilised in the present study (see text for details), according to sex and origin.

TABLE 3
Plumage colour characters of adult falcons from the Canary Islands and Iberia (percentages in parentheses).

Character	Code	Canary Islands *F. p. pelegrinoides*			Iberia *F. p. brookei*		
		Male	Female	Total	Male	Female	Total
Superciliary	1	2 (3.3)	6 (9.8)	8 (13.1)	0 (0)	0 (0)	0 (0)
	2	25 (41.0)	28 (45.9)	53 (86.9)	11 (42.3)	15 (57.7)	26 (100)
Forehead	1	16 (25.8)	14 (22.6)	30 (48.4)	0 (0)	0 (0)	0 (0)
	2	15 (24.2)	17 (27.4)	32 (51.6)	11 (42.3)	15 (57.7)	26 (100)
Nape	1	3 (4.8)	2 (3.2)	5 (8.1)	0 (0)	0 (0)	0 (0)
	2	21 (33.9)	18 (29.0)	39 (62.9)	3 (11.5)	2 (7.7)	5 (19.2)
	3	7 (11.3)	11 (17.7)	18 (29.0)	8 (30.8)	13 (50)	21 (80.8)
Back	1	8 (13.6)	4 (6.8)	12 (20.3)	0 (0)	0 (0)	0 (0)
	2	15 (25.4)	13 (22.0)	28 (47.5)	6 (23.1)	3 (11.5)	9 (343.6)
	3	7 (11.9)	12 (20.3)	19 (32.2)	5 (19.2)	12 (46.2)	17 (65.4)
Upper breast	1	13 (22.0)	7 (11.9)	20 (33.9)	2 (7.7)	1 (3.8)	3 (11.5)
	2	14 (23.7)	17 (28.8)	31 (52.5)	9 (34.6)	6 (23.1)	15 (57.7)
	3	2 (3.4)	6 (10.2)	8 (13.6)	0 (0)	8 (30.8)	8 (30.8)
Breast	1	13 (22.0)	5 (8.5)	18 (30.5)	2 (7.7)	1 (3.8)	3 (11.5)
	2	14 (23.7)	18 (30.5)	32 (54.2)	7 (26.9)	7 (26.9)	14 (53.8)
	3	2 (3.4)	7 (11.9)	9 (15.3)	2 (7.7)	7 (26.9)	9 (34.6)
Colour	1	13 (22.0)	6 (10.2)	19 (32.2)	3 (11.5)	1 (3.8)	4 (15.4)
	2	16 (23.7)	23 (39.0)	39 (66.1)	6 (23.1)	9 (34.6)	15 (57.7)
	3	0 (0)	1 (1.7)	1 (1.7)	2 (7.7)	5 (19.2)	7 (26.9)

ues lower than the mean (14.4) considering individuals from both study areas. The first three principal components retained 70.6% of the original variance (Table 4), with PC1 clearly related to general body coloration (both upper- and underparts), whilst PC2 was associated with the size and morphology of the cheek patch, and PC3 with the width of the moustachial (Table 4). When the location associated with each falcon is plotted on the principal component axes, some differentiation is observed in PC2 according to origin (Fig. 6). This suggests that two important coloration characteristics for differentiating these populations are the sizes of the cheek patch and black area below the eye, which two variables possess higher Eigenvalues in PC2 (Table 4; Fig. 6).

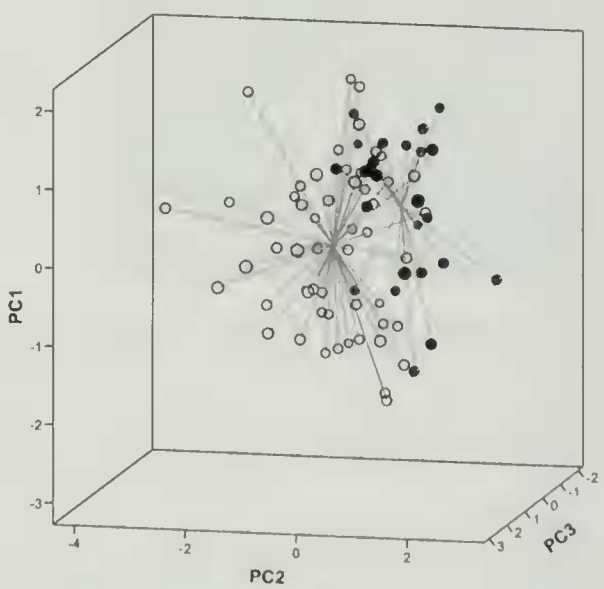

Figure 6. Locations associated with each falcon (white dots = Canary Islands and black dots = Iberia) on the principal component axes.

Visually, several birds from the Canaries are like Peregrines, having very dark upperparts, heavily barred underparts and a head pattern characterised by the complete absence of or smallest red nape patch and small white

TABLE 4
Importance of coloration variables in falcons from the Canary Islands and Iberia (see Appendix), with respect to each varimax-rotated factor of the principal components analysis (PCA). Factor loadings values larger than 0.7 are indicated in bold.

Variable	Factor loadings		
	PC1	PC2	PC3
Moustachial	0.109	0.057	**0.972**
Cheek patch	-0.099	**-0.878**	0.127
Black below eyes	0.180	**0.785**	0.358
Nape patch	0.470	0.516	0.062
Back colour	**0.808**	0.242	0.041
Upper breast	**0.816**	0.164	0.033
Breast	**0.853**	0.175	0.158
Colour	0.270	0.597	0.038
Eigenvalue	2.394	2.130	1.122
Explained variance (%)	43.7	14.3	12.6

cheek patch (Figs. 7–10), which characters are typical of Peregrine. On the other hand, two individuals from Iberia labelled *F. p. brookei* (see Fig. 11 for one example) exhibit the typical Barbary Falcon phenotype.

Due to our small sample size we cannot quantitatively compare coloration of Cape Verde *F. p. madens* with *F. p. pelegrinoides*. However, the Cape Verde type series (two adults and a juvenile) possess relatively darker upperparts than typical Barbary Falcon, as well as red napes and moderately barred breasts (Fig. 12).

Sexual differences.—Male falcons on the Canaries possess a narrower moustachial and smaller black area below the eyes than females ($U = 258.50$, $P = 0.045$ and $U = 255.00$, $P = 0.040$, respectively; Table 2). Both on the Canaries and in Iberia, males are usually paler than females in general body coloration (Table 3).

Discussion

Several mechanisms could be at work in the coloration of Peregrine populations (White *et al.* 1995). Most neighbouring populations show clines in characters reflecting environmental pressures or genetic influence (White *et al.* 1995). Some authors have suggested that Peregrine Falcon populations provide an example of Gloger's Rule (Johansson *et al.* 1998), which states that within a species more heavily pigmented individuals tend to be found in humid environments, with less-coloured individuals in dry climates (Millien *et al.* 2006). Degradation of the feathers by parasites could affect their coloration, and the intensity of parasite activity could be favoured by particular environmental conditions (e.g., Figuerola *et al.* 2003, Burtt & Ichida 2004).

Within each subspecies of Peregrine, considerable variation in coloration has been described, especially at the limits of their distribution or in areas of potential overlap (Stepanyan 1995, Ferguson-Lees & Christie 2001, Wheeler 2003). For example, Zuberogoitia *et al.* (2009a) documented that falcons breeding in northern Iberia vary in coloration, some individuals appearing like typical *F. p. brookei* and others like *F. p. peregrinus*. In North America, *F. p. anatum* displays highly variable plumage due to hybridisation during recent decades with Peregrines from different populations (White *et al.* 1995). Whereas Dementiev (1957) noted that Barbary Falcons also are highly variable individually, based on a small


2
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sample, Vaurie (1961) elected to recognise two subspecies of Barbary Falcon, and considered that geographic variation was relatively slight.

In general, the coloration of most falcons on the Canaries studied by us matches descriptions of Barbary Falcon (Clark & Shirihai 1995, Forsman 1999, Corso 2001, Ferguson-Lees & Christie 2001). However, our results also demonstrated the existence of considerable plumage variation within the population breeding on the Canaries, with some resembling *F. p. brookei* (Figs. 7–10). Some specimens of *F. p. brookei* from Iberia possess red nape patches, a narrow moustachial, paler back and less barring on the underparts (Fig. 11), suggesting a mixture of *F. p. pelegrinoides* and *F. p. brookei* characters. Although 'Barbary'-like birds from Iberia could be vagrants, some breeding falcons there possess Barbary Falcon coloration (see Zuberogoitia *et al.* 2002, 2009a). Some Canaries falcons also resemble the endemic and rare Cape Verde Peregrine Falcon (Anderson & White 2000). However, our small sample does not permit precise comparison. Sexual differences are also important in both main populations studied, with males on average paler than females (as also reported by Clark & Shirihai 1995, Corso 2001, Zuberogoitia *et al.* 2009a).

The presence of Peregrine-like birds breeding on the Canaries, and others with the Barbary phenotype but molecularly similar to *F. p. brookei* (Amengual *et al.* 1992) could be caused by several factors. It has been proven that even Peregrines belonging to sedentary populations can breed >100 km from their natal area (Zuberogoitia *et al.* 2009b), meaning that it is possible that continental Peregrines have reached the Canaries and started to breed with local falcons. This hypothesis is supported by the fact that birds with the Barbary phenotype have been recorded in Iberia and other Mediterranean countries where *F. p. pelegrinoides* does not breed (Corso 2001, Zuberogoitia *et al.* 2002, Massa & Brichetti 2003).

Another potential explanation for the presence of Peregrine-like birds in the Canaries could be related to the increase of falconry on these islands in recent years. At least one female of captive origin with a Peregrine-like appearance has been observed on Tenerife paired and holding territory with a typical male Barbary Falcon (Rodríguez *et al.* 2009). Hybridisation between raptors of captive origin and wild individuals has been recorded in several species, including Peregrine, at various places in the world (Oliphant 1991,

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Figure 2. Barbary Falcon *Falco peregrinus pelegrinoides*, Tenerife, Canary Islands, February 2006; note the extremely large rufous patches on the nape of this breeding male (José J. Hernández)

Figure 3. Barbary Falcon *Falco peregrinus pelegrinoides*, Tenerife, Canary Islands, January 2010; note the narrow superciliary stripe in this breeding female (Beneharo Rodríguez)

Figure 4. Barbary Falcon *Falco peregrinus pelegrinoides*, Tenerife, Canary Islands, January 2009; this breeding female shows all of the typical characters of *pelegrinoides*: the narrow moustachial, large cheek patch, pale forehead, large red nape patches, pale back, and paler-barred breast (Jesús Palmero)

Figure 7. Peregrine / Barbary Falcon *Falco peregrinus* ssp., Tenerife, Canary Islands, January 2010; this breeding male has a Peregrine-like appearance, with a black-hooded head, small, oblong cheek patches and very dark upperparts (Nicolás Trujillo)

Figure 8. Peregrine / Barbary Falcon *Falco peregrinus* ssp., Tenerife, Canary Islands, April 2008; this breeding female has a Peregrine-like appearance, defined by the relatively small cheek patch, large moustachial, absence of rufous patches on the nape, and dark upperparts; and it also had heavily barred underparts (Beneharo Rodríguez)

Figure 9. Peregrine / Barbary Falcon *Falco peregrinus* ssp., Tenerife, Canary Islands, January 2010; this breeding male (the mate of the bird in Fig. 4) resembles a Peregrine due to its black hood, no pale forehead, small cheek patch, large black area below the eyes and relatively small rufous nape patches, but does have a slightly barred breast (Beneharo Rodríguez)

Figure 10. Peregrine / Barbary Falcon *Falco peregrinus* ssp., Tenerife, Canary Islands, January 2008; this breeding female has a typical Peregrine-like appearance, with a relatively small cheek patch, large moustachial and heavily barred breast (José J. Hernández)

Figure 11. Ventral and dorsal views of *Falco peregrinus brookei* collected in Iberia and deposited in the collection of the Estación Biológica de Doñana CSIC, Seville, Spain (catalogue numbers from left to right: 8267a, 17701a, 21382a, 21685a and 17520a). Note the ventral and dorsal coloration typical of Barbary Falcon *F. p. pelegrinoides* in 21685a (Airam Rodríguez)

Figure 12. Ventral and dorsal views of the type series of *Falco peregrinus madens* from the Cape Verde Islands deposited in the Yale Peabody Museum of Natural History, New Haven. From left to right: adult female collected on Brava (catalogue no. 44551), adult male collected on Santiago (catalogue no. 44553) and juvenile female collected on Brava (catalogue no. 44552). Note the sparse spotting on the ventral surface, relative darkness of the upperparts and the presence of visible red patches on the napes of the adults (photographs courtesy of Yale Peabody Museum)

Lindberg & Nesje 2002, Everitt & Franklin 2009). Escaped individuals threaten wild falcons because they could compete for resources or through genetic pollution (Lindberg & Nesje 2002). Some hybrids are very conspicuous (Randler 2004) whilst others are very difficult or impossible to correctly identify in the field, especially when second- or third-generation hybrids are involved (Eastham *et al.* 2005), meaning that they can easily go undetected by ornithologists. Given that some hybrid pairings are capable of producing fertile young (Everitt & Franklin 2009), and because relatively few individuals with high breeding fitness could have a major role in shaping the morphological and genetic structure of a population (White *et al.* 1995), it is possible that escaped falcons have played some role in colour variation observed in the Canaries. In this respect, considering the rise of falconry in the Canary Islands in recent years and the escape of falcons, the appropriate regional authorities should take effective measures to prevent any genetic pollution.

Phylogeographic analyses have proven powerful in elucidating patterns of gene flow and hybridisation among raptor species (Nittinger *et al.* 2007). Detailed studies combining morphology and genetics of falcons from the Macaronesia, North Africa and the Mediterranean Basin are needed to clarify the taxonomic relationships of these populations.

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Appendix

Origin, date and sex of adult falcons (*Falco peregrinus pelegrinoides, F. p. brookei, F. p. madens* and *F. peregrinus* ssp.) considered by the present study (Al = Alegranza, L = Lanzarote including its northern islets, F = Fuerteventura, GC = Gran Canaria, T = Tenerife, H = El Hierro, CI = Canary Islands, IB = Iberia, CV = Cape Verde Islands, WRCT = Wildlife Rehabilitation Centre La Tahonilla, Tenerife, AMNH = American Museum of Natural History, New York, BMNH = Natural History Museum, Tring, EBD = Estación Biológica de Doñana CSIC, Seville, YPBM = Yale Peabody Museum of Natural History, New Haven, DBC = Private collection of Domingo Bello, * = appearance of *F. p. pelegrinoides*, ** = appearance of *F. p. peregrinus*).

ID	Origin	Date	Sex	Skin / live	Photographer or institution
1	Al	01-04-1998	♀	live	O. Trujillo
2	L	01-05-2003	♀	live	Authors
3	L	23-05-1913	♂	skin	BMNH
4	L	12-11-1904	♀	skin	AMNH
5	L	01-03-2005	♂	live	J. Palmero
6	L	01-03-2005	♂	live	J. Palmero
7	L	01-03-2005	♂	live	J. Palmero
8	L	01-03-2005	♀	live	J. Palmero
9	L	01-03-2005	♀	live	N. Trujillo
10	L	1999	♂	live	P. Felipe
11	L	1999	♀	live	P. Felipe
12	L	2006	♂	live	J. Sagardía
13	L	2006	♀	live	J. Sagardía
14	L	2006	♂	live	J. Sagardía
15	L	2006	♂	live	J. Sagardía
16	L	2006	♀	live	J. Sagardía
17	L	2006	♀	live	J. Sagardía
18	L	2006	♂	live	J. Sagardía
19	L	2006	♂	live	J. Sagardía
20	L	2006	♀	live	J. Sagardía
21	F	01-02-2008	?	live	J. J. Hernández
22	F	27-06-1902	♂	skin	AMNH
23	F	22-06-1904	♂	skin	AMNH
24	F	21-03-2009	♂	live	M. Cabrera
25	F	10-12-2009	♂	live	J. J. Hernández
26	GC	09-12-2007	♀	live	M. A. Suárez
27	GC	06-12-2008	♀	live	M. A. Suárez

ID	Origin	Date	Sex	Skin / live	Photographer or institution
28	GC	1999	♀	live	P. Felipe
29	GC	1997	♂	live	P. Felipe
30	GC	2009	♂	live	J. D. Morata
31	GC	22-08-2009	♂	live	J. D. Morata
32	GC	10-06-2009	♂	live	J. D. Morata
33	T	2006	♂	live	J. J. Hernández
34	T	2006	♀	live	J. J. Hernández
35	T	01-02-2008	♂	live	J. J. Hernández
36	T	01-02-2008	♀	live	J. J. Hernández
37	T	01-01-2008	♂	live	J. J. Hernández
38	T	01-01-2008	♀	live	J. J. Hernández
39	T	01-09-2006	♀	live	Authors
40	T	01-04-2005	♀	live	Authors
41	T	01-02-2005	♂	live	P. Felipe
42	T	08-02-2007	♀	live	WRCT
43	T	28-04-2008	♂	live	Authors
44	T	30-04-2008	♀	live	Authors
45	T	30-04-2008	♂	live	Authors
46	T	18-05-2004	♂	live	WRCT
47	T	15-05-2008	♀	skin	WRCT
48	T	19-05-2008	♀	live	WRCT
49	T	10-10-2007	♀	live	Authors
50	T	29-09-2009	♀	live	Authors
51	T	20-09-2008	♂	live	Authors
52	T	20-09-2008	♀	live	Authors
53	T	14-11-2008	♂	live	Authors
54	T	14-11-2008	♀	live	Authors
55	T	02-01-2009	♂	live	J. Palmero
56	T	02-01-2009	♀	live	J. Palmero
57	T	02-01-2010	♀	live	Authors
58	T	02-01-2010	♂	live	Authors
59	T	07-01-2010	♂	live	N. Trujillo
60	T	10-01-2010	♀	live	Authors
61	T	10-01-2010	♂	live	Authors
62	T	25-01-2010	♀	live	J. J. Hernández
63	H	01-03-2004	♂	live	Authors
64	H	15-04-2008	♀	live	D. Trujillo
65	Cl	?	?	skin	DBC
66	Cl	?	?	skin	DBC
67	IB	20-11-1962	♀	skin	EBD
68*	IB	11-12-1934	♀	skin	EBD
69	IB	08-01-2003	♀	skin	EBD
70	IB	1940	♀	skin	EBD
71	IB	1960	♀	skin	EBD
72	IB	1940	♂	skin	EBD
73	IB	1991	♀	skin	EBD

ID	Origin	Date	Sex	Skin / live	Photographer or institution
74	IB	24-03-1991	♀	skin	EBD
75	IB	14-06-1983	♂	skin	EBD
76	IB	30-08-1995	♂	skin	EBD
77	IB	18-10-2000	♂	skin	EBD
78	IB	15-08-1985	♂	skin	EBD
79*	IB	11-10-1990	♂	skin	EBD
80	IB	1994	♂	skin	EBD
81	IB	05-07-1995	♀	skin	EBD
82	IB	22-02-1990	♀	skin	EBD
83	IB	11-1987	♀	skin	EBD
84	IB	1984	♀	skin	EBD
85	IB	1986	♀	skin	EBD
86	IB	30-11-1996	♂	skin	EBD
87	IB	28-09-2006	♀	skin	EBD
88	IB	1983	♀	skin	EBD
89	IB	26-06-1997	♀	skin	EBD
90**	IB	24-09-1998	♂	skin	EBD
91	IB	11-1990	♂	skin	EBD
92	IB	01-10-1977	♂	skin	EBD
93	CV	22-04-1924	♂	skin	YPBM
94	CV	1924	♀	skin	YPBM

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